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PERSONALITY CHARACTERISTICS OF INNOVATIVE PHYSICS TEACHERS.

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TO DETERMINE HOW THE INNOVATIVE PHYSICS TEACHER'S PERSONALITY DIFFERS FROM HIS NON-INNOVATIVE COLLEAGUE'S AND HOW HIS PERSONALITY IS RELATED TO HIS KNOWLEDGE OF PHYSICS AND HIS ATTITUDES TOWARD TEACHING, 36 MALE PHYSICS TEACHERS WERE GIVEN THE ALLPORT-VERNON-LINDZEY STUDY OF VALUES (AVL), THE EDWARDS PERSONAL PREFERENCE SCHEDULE (EPPS), THE MINNESOTA TEACHER ATTITUDE INVENTORY (MTAI), AND THE UNPUBLISHED TESTS OF SELECTED TOPICS IN PHYSICS (TSTP). IT WAS FOUND THAT (1) ON THE AVL THE SUBJECTS SCORED SIGNIFICANTLY HIGHER THAN THE NORM FOR UNSELECTED TEACHERS (AS PROVIDED IN THE TEST MANUAL) ON AESTHETIC AND THEORETICAL VALUES AND LOWER FOR ECONOMIC, POLITICAL, AND RELIGIOUS VALUES, (2) ON THE EPPS THE SUBJECTS SCORED SIGNIFICANTLY HIGHER THAN THE NORM FOR MALE HIGH SCHOOL SCIENCE TEACHERS (AS REPORTED IN A PRIOR STUDY) ON AUTONOMY AND HETEROSEXUALITY AND LOWER ON AFFILIATION AND ABASEMENT, (3) THE SUBJECTS ALSO SCORED LOWER ON AFFILIATION ON THE EPPS THAN DID 91 UNSELECTED TEACHERS, (4) NO SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN THE SUBJECTS' MEAN SCORE ON TEACHING ATTITUDES (AS MEASURED BY THE MTAI), AND THE NORM FOR MALE SECONDARY SCHOOL TEACHERS, THAN DID 118 OTHER PHYSICS TEACHERS ATTENDING SUMMER INSTITUTES, (5) TEACHING ATTITUDES CORRELATED SIGNIFICANTLY WITH SOCIAL AND CHANGE VALUES, AND WITH KNOWLEDGE OF PHYSICS, AND (6) SIMILARITIES BETWEEN THE PERSONALITY CHARACTERISTICS OF INNOVATIVE PHYSICS TEACHERS AND CREATIVE SCIENTISTS WERE NOTED. (AW)

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Personality Characteristics of Innovative Physics Teachers

INTRODUCTION

How does the innovative physics teacher's personality differ from that of his colleagues? And how are dimensions of his personality related to his knowledge of physics and his attitudes toward teaching? This paper provides some tentative answers to these questions, based upon the responses of a sample of teachers attending a summer briefing session for a new high school physics curriculum.*

As Watson[1] has pointed out, behavioral scientists have done very little personality research on students and teachers in science courses. The few extant studies of science teachers have not compared this group with teachers of other subjects. Moreover, a number of interesting questions have been raised about the science teacher's personality, but few have been investigated empirically.[1] One study is relevant to the present research, however. Lee[2] contrasted personality measures of 66 male science majors planning to be teachers with 61 males majoring in science but planning other careers. He found that those planning to

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teach scored significantly higher on the Emotional Stability, Objectivity, Personal Relationships, and social scales of the Guilford-Zimmerman Temperament Survey. The prospective teachers also scored higher on the Social scale of the Allport-Vernon-Lindzey Study of Values, and particularly high on the *Welfare Worker* scale of the Strong Vocational Interest Blank (SVIB). As one might expect, men planning to teach scored lower than their fellow science majors on the *Technical Worker* of the SVIB. These results are consistent with other studies which have typically found that teachers have high social and affiliative interests, values, and needs. They enjoy being with others; they are interested in students; and they look back with pleasure on their own childhood relations.[3]

Volunteers: A Select Group

But the subjects of this study are a select group—physics teachers who volunteered to teach using new materials and who traveled across the country to attend a summer briefing session. Their scores were compared with published normative data on unselected high school teachers. Our own experiences in science teaching (elementary general science and high school physics) suggested that physics teachers might differ considerably from teachers in general. Experiences in working with them on curriculum development confirmed our general impressions: they seemed to be more intelligent than most teachers, and to have higher intellectual values. At the same time, they did not seem to be as concerned with warm human relationships as other teachers. Perhaps this is a conventional stereotype of the physics teacher, but perhaps it is, in part, true. The intent of this research was to investigate the differences between these physics teachers and teachers in other fields on selected cognitive and affective measures.

Subjects

The subjects of the study were 36 male physics teachers who attended a briefing session for a new physics course during the summer of 1966. (Two female teachers in the group were excluded from the analyses because such a small number of cases is not likely to produce statistically significant comparisons with normative data). The average age of the men was 38, with a range of 22 to 59. They had taken an average of 40 hours of college physics, 31 hours of other science courses, and 26 hours of mathematics. All had bachelor's degrees, 22 had one master's degree, and 6 had two master's degrees. All but three taught in public schools. Eleven taught in urban schools, 11 in suburban, and 14 in rural areas. On the average they had 12 years of teach-

ing experience and 8 years in physics teaching. The teachers came from 17 states scattered throughout the country.

Instruments

Four instruments were administered to the teachers: The Allport-Vernon-Lindzey Study of Values (AVL)[4], the Edwards Personal Preference Schedule (EPPS)[5], the Minnesota Teacher Attitude Inventory (MTAI)[6], and the Test of Selected Topics in Physics (TSTP, unpublished). The three published tests have been used extensively for research on teachers. The AVL has six scales based upon Spranger's Types of Man: they have been labeled Theoretical, Economic, Aesthetic, Social, Political, and Religious[7].* The split-half reliabilities of the AVL scales range from .84 to .95. The *Manual* provides norms for 126 male teachers in Wisconsin high schools.

Personality Variables

The Edwards Personal Preference Schedule (EPPS) provides measures on 15 personality variables derived from the comprehensive taxonomy of manifest needs by Murray: Achievement, Deference, Order, Exhibitionism, Autonomy, Affiliation, Intraception, Succorance, Dominance, Abasement, Nurturance, Change, Endurance, Heterosexuality, and Aggression. The average profile stability coefficient reported in the *Manual* is .74; the split-half reliabilities range from .60 to .84. The Schedule also yields a consistency score, that is, the extent to which a person answers the same questions in exactly the same way. The scores of the subjects on consistency were all above the satisfactory level. Although no separate norms for teachers are reported in the *Manual*, Jackson and Guba[8] surveyed the manifest needs of a large sample of midwestern teachers and reported separate means and standard deviations of 91 male secondary school teachers.

The Minnesota Teacher Attitude Inventory (MTAI) purports to measure "those attitudes of a teacher which predict how well he will get along with pupils in interpersonal relationships, and indirectly how well satisfied he will be with teaching as a vocation."[6] The split-half reliability of the instrument is .87, and it is correlated (.46, .57, and .30, respectively) with ratings of the

* The AVL and the EPPS are ipsative, that is, by contrasting successive pairs of values and manifest needs, scores are obtained that are relative to one another. This kind of test requires the person taking it to allocate points to the desirability of two choice options such as the following: "Are you more interested in reading accounts of the lives of such men as (a) Alexander, Julius Caesar, and Charlemagne; or (b) Aristotle, Socrates, and Kant?" In choosing one over another, the respondent is weighing relative rather than absolute values, in this case, Political and Theoretical.

teacher by principals, experts, and pupils. The *Manual* reports norms for 218 male high school teachers.

Content Knowledge The last instrument, the Test on Selected Topics in Physics (TSTP), is a selection of 36 items from a collection of 360 multiple-choice items on general physics. The test taps a wide range of topics in physics, but has a heavier concentration of philosophical, historical, and interdisciplinary items than traditional physics tests. Its internal consistency calculated with the Kuder-Richardson Formula 20 is .82.

Procedure The instruments were administered and scored according to the standard instructions in the test manuals. The means and standard deviations were calculated for all sub-scores. The means were contrasted with those from the norm groups previously described. The differences in mean scores were evaluated for statistical significance with two-tailed t-tests. In addition, the MTAI and the TSTP were correlated with the scores obtained from the six AVL values and the 15 EPPS manifest needs.

Values Table 1 shows that the AVL is highly sensitive to the differences in values between physics teachers and teachers in other fields. Significant differences were found on five of the six scales. Moreover, there is more than a seven-point mean score difference on four scales. These differences are highly unlikely to have occurred by chance (a probability of less than one in a thousand). The hypothesis that innovative physics teachers have higher intellectual values than the normative sample is strongly supported (p less than .01): their mean score on the Theoretical scale is 49.4, and the group mean of 126 teachers in other fields is 42.1. However,

TABLE 1 Comparison of Physics Teachers and Teachers in Other Fields on the Allport-Vernon-Lindzey Study of Values

	Physics Teachers (N = 36)		*Unselected Teachers (N = 126)*			
Value	*M*	*SD*	*M*	*SD*	*D*	*t*
Theoretical	49.4	6.9	42.1	7.4	7.3	5.32**
Economic	34.4	8.5	41.7	7.9	−7.3	4.81**
Aesthetic	40.8	7.1	32.9	8.0	7.9	5.36**
Social	36.3	8.4	37.3	5.7	−1.0	.83
Political	38.2	6.3	41.3	5.8	−3.1	2.75**
Religious	36.2	12.8	44.7	7.4	−8.5	5.04**

* One and two asterisks pertain to t's significant at .05 and .01 levels, respectively (for consistency with Table 2).

Note: all statistics in this table are for male teachers experienced in high school teaching.

there is no evidence that the sample of physics teachers have lower Social values. Although they scored one point lower than the norm group the difference is not significant.

Higher Aesthetic Values

The analysis also reveals that these physics teachers scored higher on Aesthetic values (p less than .01) but lower on Economic (p less than .01), Religious (p less than .001), and Political (p less than .01) values than teachers in other fields. To paraphrase the *Manual* descriptions of the value typologies showing significant differences: physics teachers have a greater interest in the discovery of *truth* (Theoretical), and value more highly *form* and *harmony* (Aesthetic), but have less interest in what is *useful* (Economic), in *power* (Political), and in *unity*, "the comprehension of the cosmos in its totality" (Religious) than other teachers.

Lower Affiliation Needs

Table 2 is a summary of the statistics on the EPPS for (1) the present sample, (2) norms on 91 male secondary school teachers reported by Jackson and Guba[8], and (3) a sample of 53 male secondary school science teachers reported by Merrill[9]. The

TABLE 2 Comparison of Physics Teachers with Science Teachers and Teachers in Other Fields on the Edwards Personality Preference Schedule

	A *Physics Teachers* *(N = 35)*		*B* *Unselected Teachers* *(N = 91)*		*C* *Science Teachers* *(N = 53)*					
Need	*M*	*SD*	*M*	*SD*	*M*	*SD*	$D_{A\text{-}B}$	*t*	$D_{A\text{-}C}$	*t*
Achievement	16.5	3.7	15.6	3.5	16.8	4.0	.9	1.31	−.2	.28
Deference	13.6	4.0	14.2	4.1	14.2	4.2	−.6	.71	−.5	.61
Order	13.1	5.4	12.9	4.8	12.4	4.2	.2	.16	.6	.63
Exhibitionism	13.9	3.5	13.5	3.8	13.2	3.7	.4	.59	.7	.89
Autonomy	15.3	4.4	13.9	4.1	13.2	4.3	1.4	1.62	2.0	2.12**
Affiliation	13.2	4.1	15.0	4.0	15.6	4.2	−1.8	2.17**	−2.4	2.61**
Intraception	16.1	5.0	14.8	4.6	15.0	5.1	1.3	1.40	1.1	1.01
Succorance	9.5	5.0	9.5	4.0	9.9	3.8	.0	0.00	−.4	.44
Dominance	16.4	4.6	16.8	4.6	16.7	4.7	−.4	.39	−.2	.34
Abasement	11.0	5.4	12.3	4.9	13.9	4.3	−1.2	1.23	−2.9	2.73**
Nurturance	12.6	5.3	13.9	4.9	13.8	4.4	−1.3	1.27	−1.2	1.49
Change	16.1	5.3	14.8	4.9	16.0	4.0	1.3	1.29	.0	.05
Endurance	16.2	4.7	15.5	5.0	16.2	5.6	.7	.72	.0	.03
Heterosexuality	15.2	6.5	14.7	6.7	10.9	5.7	.5	.36	4.3	3.25**
Aggression	12.3	4.3	12.7	4.9	12.0	4.1	−.4	.46	.2	.29

* One and two asterisks pertain to t's significant at the .05 and .01 levels, respectively.
Note: all statistics in this table are for male teachers experienced in secondary school teaching.

scores obtained on this instrument support the second part of our hypothesis: these physics teachers are significantly lower than both science teachers and teachers in other fields on Affiliation (p less than .05). As described in the *Manual*, affiliation pertains to friendship activities; being loyal, sharing, forming strong attachments, and doing things with friends rather than alone. The physics teacher's scores are not different from the other two groups on related social scales—Nurturance and Succorance. However, they are higher than other science teachers (p less than .05) on Autonomy: to say what one thinks, to be independent, unconventional and critical, and to avoid situations where one has to conform. These physics teachers also differ from other science teachers in scoring lower (p less than .05) on Abasement (feeling guilty, giving in rather than having one's way, and feeling depressed by inability to handle situations), and much higher (p less than .01) on Heterosexuality (going out with members of the opposite sex, being regarded as attractive by members of the opposite sex).

Attitudes and Knowledge

No significant difference was found for the present sample between the mean score on teaching attitudes (MTAI) and the norm for male secondary school teachers reported in the *Manual*. However, on a measure of physics knowledge, TSTP, the mean score of the present sample is much higher than the mean of 118 other physics teachers attending three summer institutes sponsored by the National Science Foundation.[10] The mean for the present sample of teachers is 30.3, with a standard deviation of 5.6. The corresponding statistics for institute enrollees are 21.6 and 6.5. The t value is 6.4 (p less than .01).

Personality and Knowledge

Table 3 presents the personality variables (AVL and EPPS) which correlate significantly (p less than .05) with physics knowledge (TSTP) and teaching attitude (MTAI). The measure of teaching attitude is correlated .56 with Social (philanthropic and altruistic values, AVL) and .33 with Change (to experience novelty, to experiment and try new things, EPPS). Physics knowledge (TSTP) is correlated negatively, -.40 with Intraception (to introspect, to judge people by why they do things rather than by what they do, EPPS). Also, knowledge of physics (TSTP) is positively correlated, .42, with teacher attitude (MTAI).

CREATIVITY: SCIENTIFIC AND PEDAGOGICAL

Several of the findings suggest similarities between personality characteristics of innovative physics teachers and creative scientists. The teachers in the sample scored much higher than other teachers on values emphasizing the discovery of *truth* (Theo-

TABLE 3 Correlations Between 1) AVL Values and EPPS Needs, Significantly Related to 2) TSTP Knowledge of Physics and MTAI Teaching Attitudes

	Social	*Intraception*	*Change*	*Knowledge*	*Attitude*
Social		−.075	.463**	.083	.559**
Intraception	−.075		−.441**	−.402*	−.245
Change	.463**	−.441**		.042	.327*
Knowledge	.083	−.402*	.042		.425**
Attitude	.559**	−.245	.327*	.425**	

* One and two asterisks pertain to correlations significant at the .05 and .01 levels, respectively.

retical) and the *form* and *harmony* of the physical universe (Aesthetic, *italics* from the AVL *Manual*[4]). It is possible that they have identified with former research professors in graduate school or with creative physicists such as Newton, Einstein, and Fermi, whose dominant activity was the pursuit of truth and harmony in the physical universe. Their relatively low scores on Affiliation and Abasement and their relatively high scores on Autonomy are reminiscent of the social and intellectual independence of creative scientists reported by Eiduson[11] and Roe[12]. It is probable that subsequent work on socialization processes in teachers along the lines of Molchen[13] and Weller[14] will contribute to our understanding of these affective characteristics of teachers. For example, Weller found that in a large national sample of science teachers, undergraduate concentration in education was significantly correlated with attitudes toward students.

Creative Teaching: Personality and Role

The finding that on the EPPS these physics teachers differ more from other high school science teachers than they differ from unselected male high school teachers is puzzling to say the least. While the present teachers are less affiliative than both of the other groups, they are more autonomous and heterosexual, but less abasing than the other science teachers. Merrill[9] described his sample of experienced science teachers as obsequious, eternally patient, meek, and with less achievement and individual drive than other groups. Jackson and Guba[8] had suggested earlier that the "meek" need-structure of practicing teachers may be the result of the occupational selection process, or a personality change brought about by the institutional pressures of the teaching role. It is apparent that the present sample of innova-

tive physics teachers does not manifest these characteristics to the extent that Merrill's sample of science teachers does.

Creative Teaching and Confidence

The constellation of significant correlations among social values, need for change, and teaching attitude has been found to correlate moderately with teacher desirability as perceived by pupils, principals, and trained observers.[6] These correlations also exemplify the "warm, outgoing teaching attitudes, found in factor analytic studies of teacher personality[15]. It is interesting to note that physics teachers who are high on teaching attitudes as measured by the MTAI tend to know more physics ($r = .42$, p less than .01). Teachers with less physics knowledge, in addition to scoring lower on teaching attitudes, also tend to be more Intraceptive—more introspective and analytic about the motives, feelings, and behavior of others. One is led to suspect that physics teachers who do not have a comprehensive grasp of their subject generalize their uncertainty and anxiety to their teaching attitudes and inter-personal relationships. This syndrome is quite the opposite of that of the high scorers on the achievement test who tended to be less Intraceptive and have high scores on the MTAI. These findings suggest that experienced teachers who have more competence in their field have more confidence and self-respect. They consequently have the courage to be different and to stand alone if necessary. The qualities of leadership found in these innovative teachers, therefore, are not surprising.

Competence and Togetherness

In the contemporary dialogue (or perhaps one should say argument) between the establishments of Education and Science concerning teacher education in the sciences, the issues seem to center around the polarities of hard-boiled competence on one hand, and tender-minded togetherness on the other. Thus in recent years we have seen the thrust of post-Sputnik scientific "rigor" in education, against the general texture of neo-Progressive, "democratic" life-adjustment. The data presented here do not suggest the contradiction of these characteristics in physics teachers. While as a group they resemble creative scientists, the physics teachers who know their subject best are also more likely to have warm, positive teaching attitudes.

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ABSTRACT Innovative physics teachers scored higher on theoretical and aesthetic values than other male high school teachers, but lower on economic, religious, and political values. The innovative teachers scored much higher on a physics achievement test than physics teachers in three summer institutes. While they are close to the norm for male secondary school teachers on teaching attitudes, they have a lower need for affiliation than this group. Compared with other male high-school science teachers, they are less abasing and affiliative, but more autonomous and heterosexual. Because of their relatively high intellectual and artistic values, and needs for autonomy and social independence, their profiles resemble those of creative scientists. Two personality variables suggesting a "warm, outgoing teaching attitude factor" are significantly correlated with the teachers' knowledge of physics. The teachers who have a firm grasp of their subject not only have more positive attitudes toward teaching, but appear to be less intraceptive.

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